

# MOTOR SYSTEMS

A Special Supplement to *Energy Matters*



A data logger is set up to capture real-time motor systems data.



Instantaneous measurements are collected as part of the PAT motor systems analysis.

PG&E SPONSORED A  
DEMONSTRATION PROJECT TO  
IDENTIFY AND QUANTIFY POTENTIAL  
MOTOR SYSTEM SAVINGS BY  
ACCURATELY MEASURING MOTOR  
PERFORMANCE.

## PG&E Takes Market Approach to Establishing Motor Performance Analysis

With a service area of 70,000 square miles in Northern and Central California, Pacific Gas and Electric (PG&E) transmits and delivers energy to more than 13 million customers. That makes PG&E one of the largest providers of natural gas and electricity.

As part of its market transformation strategy, PG&E, an OIT BestPractices Allied Partner, works with industrial and commercial customers on improving efficiency and reducing energy demand. The company targets industrial energy systems as areas with significant potential for savings and improved performance and reliability. More and more, the utility's customers are seeking ways to unlock that potential. PG&E offers some of the keys in the form of technical assistance, such as training, testing, and system analysis.

Recently, PG&E sponsored a demonstration project to identify and quantify potential motor system savings by accurately measuring motor performance in a variety of industrial settings. The project involved developing and testing the Performance Analysis Testing (PAT) tool. The PAT tool uses a data logger to record real-time data to eliminate some of the guess work and to provide a standard method for analysis of motor systems.

What made the project unique is that PG&E demonstrated a viable market approach to motor performance analysis. The PAT tool project demonstrated that customers have a need for accurate motor performance analysis—and that the PAT analysis could be a service niche for trade allies.

### The PAT Tool

Development of the PAT tool began as an idea to engage the market with a method to assess motor system performance and provide very accurate data. Jim

Hanna, PG&E's Senior Project manager, oversaw development; Mats Falk of Flow-care Engineering, Inc. and Dr. Howard Penrose designed procedures; and field testing and PAT demonstration were completed by Colman Snaith of Newcomb-Anderson & Associates. According to Hanna, "Other software tools in the past have required the user to make some assumptions and haven't allowed for real-time readings." More accurate data not only helps identify opportunities, but also helps to justify improvements that lead to better motor efficiency and avoided motor failure.

Using OIT's *MotorMaster+* software as the basis, PAT provides a basic analysis to determine if motor replacement presents a good opportunity for improved efficiency. By inputting simple motor nameplate data and electrical measurements, the tool accurately determines if replacing an installed motor with a premium efficiency model makes sense for that facility.

In addition, PG&E added advanced analysis features designed to evaluate the mechanical and electrical condition of an installed motor. The advanced analysis features included motor circuit and vibration analysis.

The combination of information—and the accuracy with which it is obtained—showed PAT's potential as a good tool for motor repair versus replacement decisions. These features proved appealing to PG&E's customers and trade allies alike.

### Putting the Tool to the Test

The goals of testing PAT were threefold:

1. To help refine the tool itself and determine if it would achieve repeatable and accurate results,
2. To determine the energy- and cost-saving potential, and

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THE DEMONSTRATION REVEALED  
THAT INDUSTRIAL CUSTOMERS  
RESPOND POSITIVELY TO SUCH  
A MOTOR PERFORMANCE  
EVALUATION METHOD.



One of the PAT testing team checks connections through the data logger interface.



The tester reviews motor data before disconnecting the data logger.

PG&E Takes Market Approach  
*continued from page 1*

3. To determine the marketability of a motor program based on the tool.

To accomplish these goals and get a fair assessment of the PAT method, PG&E targeted industrial customers with high energy intensities in their manufacturing processes.

When PAT was ready for testing, PG&E identified six industrial facilities within its service area to participate in the demonstration project. They included:

- A paper mill
- A petroleum extraction and processing plant
- A produce cooling and storage facility
- A granite quarry
- An onion and garlic dehydration and milling facility
- An engineered lumber product manufacturer

"We selected these companies because they had high energy use," explains Hanna. "They also represent a diverse mix of IOF industries," he adds. In addition, the processes at these facilities required long hours of motor operation, which allowed testing under variable conditions. Besides says Hanna, "Improvements are most cost-effective for motors that operate over a certain number of hours."

Together with its demonstration partners, PG&E analyzed potential for improvements to 245 motors in the 5 to 200 hp range. At the same time, the company took stock of the overall PAT approach.

**Results**

The demonstration project identified significant opportunities for improvement at each of the facilities. Of the 245 motors analyzed, 198 showed at least one defi-

ciency. Many of the motors were oversized, overloaded, or inefficient. The results suggested that almost half of the motors analyzed should be replaced with properly sized, premium efficiency motors.

In addition, 20 motors were analyzed using the advanced condition evaluation techniques. Almost all of the motors included in the advanced analysis were identified during the basic analysis phase as having potential maintenance problems. This project confirmed that end users, such as those who took part in the testing, could use PAT to help establish their motor management policies. As part of an overall motor management strategy, the tool provides the means to both evaluate the potential benefits of upgrading motors and target potential maintenance needs.

Equally important, the PG&E demonstration revealed that industrial customers respond positively to such a motor performance evaluation method. "When we presented data to the companies, we received immediate feedback, and it was extremely positive," says Hanna. "We heard remarks like 'This is great! We haven't seen this before,' or 'Can you test all our motors?'"

**Next Steps for PAT**

Although the PAT approach shows promise, PG&E is working with customers to solve immediate needs brought about by the energy situation in California. Thus, efforts to market the tool to trade allies are on hold for now. Meanwhile, PG&E will continue to fine-tune the tool, and Hanna says his company hopes to eventually market it as part of its motor efficiency program. "We've already done the hard work and proven the tool's effectiveness," he notes about the demonstration project's success. ●

**THE ALLIED PARTNERSHIP ADVANTAGE**

*As an Allied Partner, PG&E has access to many BestPractices resources and tools that augment its industrial energy efficiency services. PG&E's demonstration project is a good example of how one BestPractices tool, MotorMaster+, can be adapted and applied to meet customers' needs. By applying a market approach, PG&E has increased its value to industrial customers and trade allies.*

*Likewise, your company can gain the competitive advantage of Allied Partnership. Expand your range of services by incorporating BestPractices software, publications, and training into your program. In addition, a partnership with BestPractices will reinforce your company's credibility with customers—and can even increase its visibility when you share successes with others in DOE-produced publications and announcements.*

*Learn more by logging on to [www.oit.doe.gov/bestpractices/get\\_involved/](http://www.oit.doe.gov/bestpractices/get_involved/).*

## Independent Report: Motor Challenge Program Highly Cost-Effective

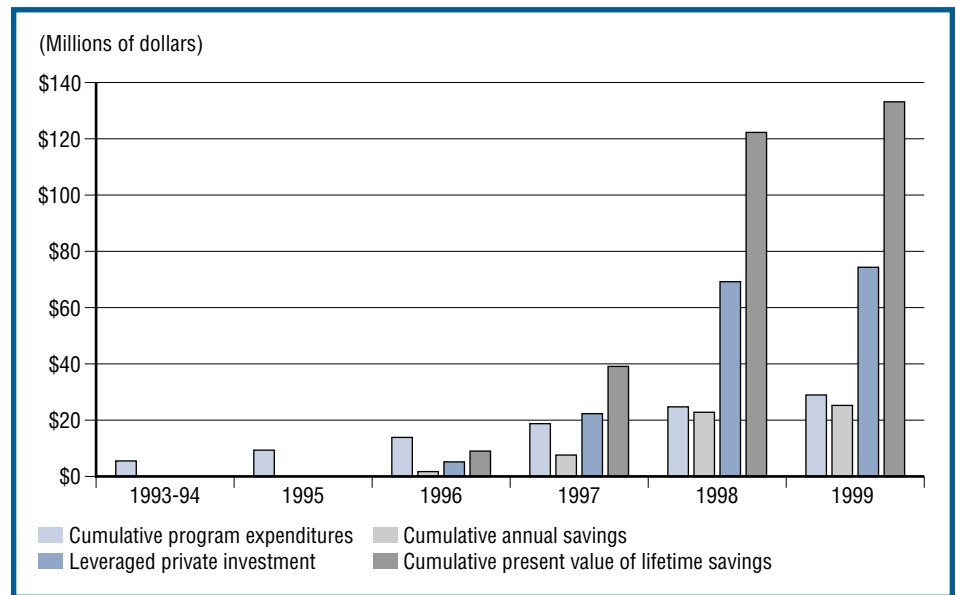
A recent independent evaluation of OIT's Motor Challenge Program concluded that the program has enabled industrial facility operators to significantly reduce energy consumption and has been "highly cost-effective." The report, entitled *Evaluation of the U.S. Department of Energy Motor Challenge Program*, was written by XENERGY, Inc., of Burlington, Massachusetts, a 25-year-old energy services and consulting company.

What does this mean to you? In a nutshell, by tapping into OIT's valuable tools and resources for improving plant efficiency, you can—and continue to—improve the bottom line.

Launched in the fall of 1993, the Motor Challenge Program was managed by OIT in partnership with U.S. industry. In winter of 1999-2000, all of OIT's Challenge programs became part of the BestPractices initiative. BestPractices delivers energy-saving products, services, and technologies to help industry increase efficiency, reduce waste, and boost productivity.

The Motor Challenge Program offered two kinds of program activities, which are still the basis of BestPractices.

■ **Motor Systems Efficiency Tool Development and Dissemination.** The Motor Challenge Program developed a set of project planning and preventive maintenance tools designed to help industry and industrial supply-chain vendors and consultants identify and cost-justify specific actions to reduce energy use in their motor systems. The most well known of these tools is the *MotorMaster+* motor selection and management software, which has been distributed to thousands of industrial end users, vendors, and consultants nationwide. On average, the registered *MotorMaster+* users are large industrial facilities. XENERGY estimated that they use roughly 20 times more motor system energy than the average manufacturing plant and 5 times as much as a typical utility-sponsored motor program participant. Altogether, the evaluation estimated that the population of registered



**Key cost and benefit outcomes of the Motor Challenge Program from program inception through September 1999.**

*MotorMaster+* users consumed 165,120 GWh per year in electricity versus 1.1 million GWh per year for industrial users as a whole. You can view the BestPractices Motors Web site and download *MotorMaster+* at [www.oit.doe.gov/bestpractices/motors/](http://www.oit.doe.gov/bestpractices/motors/).

■ **Partnership Programs.** The Motor Challenge staff worked with many different organizations to ensure that program tools reach end users and vendors when they are making motor system purchase, management, and maintenance decisions. The Allied Partner Program worked with more than 200 organizations including vendors and program operators, such as utilities, industry associations, and government agencies. Allied Partners are private companies that provide equipment and services to industry. Their primary activity is their involvement in project teams that assess plant efficiencies and demonstrate application of efficiency improvements. According to the report, Allied Partners can take credit for saving more than 200,000 MW per year, which translates into a savings of about \$9.8 million annually. To see how you can get involved in Allied Partners, access the BestPractices Allied Partner Web site at [www.oit.doe.gov/bestpractices/meet\\_partners/](http://www.oit.doe.gov/bestpractices/meet_partners/).

### Key Evaluation Results

Using a variety of research and analysis methods, XENERGY found the following.

- Information, motor management tools, and technical services delivered by the Motor Challenge Program from inception through September 1999 encouraged and enabled industrial facility operators to reduce energy consumption by 520 GWh per year. These savings are valued at \$24.9 million at current rates, with annual avoided air emissions of 130,000 metric tons of carbon equivalent per year.
- The program was highly cost-effective. Total program expenditures from inception through September 1999 amounted to \$29.2 million. Program activities stimulated nearly \$75 million of private investment in energy efficiency improvements to industrial motor systems. The discounted present value of lifetime savings from improvements attributable to Motor Challenge amounted to more than \$132 million—more than 4 times the amount of program expenditures from inception through September 1999.

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## "NEMA Premium" Program Drives Application of Efficient Motors for Energy Cost Savings

*Benefits extend to end users, manufacturers, and environment*

The National Electrical Manufacturers Association (NEMA), announces its Premium Motor program, an initiative aimed at helping U.S. motor manufacturers expand the application of premium-efficiency three-phase motors and provide customers with a high level of motor performance. The program will focus on qualifying and labeling motors that meet an industry-defined standard of "premium efficiency." For OEMs and end users, NEMA Premium labeling will provide assurance that products meet the highest standards for energy efficiency.

Traditionally, there has been no industry-developed standard defining high-efficiency or premium-efficiency motors. Today, power supply issues and utility deregulation bring attention to the need to help motor users optimize motor system efficiency. The Energy Policy Act (EPA) of 1992 imposed energy efficiency standards on many classes of motors. Confusion remained, however, because of a lack of consistency in describing integral premium-efficiency performance.



The NEMA Premium campaign, driven by the NEMA Motor and Generator Section's Energy Management Taskforce, addresses the confusion by going beyond EPA efficiency requirements while relying on its procedures and labeling methods of efficiency levels. NEMA Premium will cover more motor types and sizes than those covered under EPA, including 1

to 200 hp definite- and special-purpose motors, medium-voltage motors, and motors up to 500 hp.

The campaign is based on present-day NEMA Design A and B motor performance, including locked rotor current requirements. The focus will be on proven NEMA motor designations to reduce users' risk of motor misapplications. Products are tested in accordance with existing standards, including the NEMA MG1 standard.

End users will be able to identify premium efficiency motors by the "NEMA Premium" label and logo, to be used only with products that meet or exceed NEMA Premium motor efficiency levels. Partnering manufacturers will operate under a memorandum of understanding signed with NEMA to use the Premium label.

"NEMA Premium is unique because it's a realistic standard, it's straightforward to

implement, and it covers a huge range of products," said Robert Boteler, chairman of the Energy Management Taskforce. "In addition, because it's a voluntary program and is sponsored by an established and well-recognized manufacturers' organization, it fits a national need for premium efficiency standards."

Based on data from DOE's *United States Industrial Electric Motor Systems Market Opportunities Assessment* report, Boteler estimates the program, including commercial and agricultural applications, could save 5,800 GW of electricity and prevent the release of nearly 80 million metric tons of carbon into the atmosphere over the next 10 years. "It would be the equivalent of keeping 16 million cars off the road in the next decade," he noted.

DOE and NEMA plan to develop joint activities that will expand awareness of the benefits of premium-efficiency motors and efficient motor systems. These could include presentations and materials to educate users on premium-efficiency motors and motor systems. In addition, DOE and NEMA are collecting data on motor products, which will be included in the *Motor-Master+* database and will highlight NEMA Premium products.

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### Motor Challenge Program Report *continued from page 3*

The figure on page 3 excerpted from the report, shows cumulative program expenditures, leveraged private investments in efficient motor system equipment, annual energy savings attributable to the program, and the present value of those savings for each year in the period under evaluation.

XENERGY used a variety of research methods to obtain the information to address the evaluation criteria. These methods included analysis of program records; interviews with end users, vendors, and government officials who participated in the program; and application of motor system inventory information from the *United States Industrial Electric Motor Systems*

*Market Opportunities Assessment (Market Assessment)*<sup>1</sup> to estimate energy savings.

In summary, the report concluded that the Motor Challenge efforts were very cost-effective. The same efforts are being continued under BestPractices.

Don't miss out! If you haven't yet checked into how BestPractices can help you save energy and money, log on to [www.oit.doe.gov/bestpractices/](http://www.oit.doe.gov/bestpractices/). ●

<sup>1</sup> XENERGY Inc. (1998) *United States Industrial Electric Motor Systems Market Opportunities Assessment*. U. S. Department of Energy's Office of Industrial Technologies and Oak Ridge National Laboratories. See Section 1.2.1 of this report for more details and key findings.

### ENERGY MATTERS READERS' IMPACT

Energy Matters, formerly Turning Point, has played a role in helping industry be more efficient. In the report, XENERGY cites an Energy Matters reader survey that indicated roughly one-third of you used information found in the newsletter to carry out some kind of motor system energy improvement. The report further cited an Energy Matters marketing assessment report that estimated that these actions saved more than 35,000 MWh per year, or nearly \$1.7 million.

## Qualification Workshops Meet the Need for PSAT Software Experts

On April 9th and 10th, 2001, in Blacksburg, Virginia, DOE held the first in a series of workshops to qualify pumping system professionals in the use of the Pumping System Assessment Tool (PSAT) software.

Pumping systems are among the most energy-consuming industrial systems. Several years ago, DOE began looking for a way to educate pumping system manufacturers, distributors, consultants, and end users on the benefits of applying a systems approach to improve pumping efficiency. This led to the development of the PSAT.

PSAT helps users assess energy savings opportunities in pumping systems, relying on field measurements of flow rate, head, and either motor power or current to perform the assessment. Using algorithms from Hydraulic Institute (HI) standards and motor performance characteristics from DOE's *MotorMaster+* database, PSAT quickly estimates existing pump and motor efficiency and calculates the potential energy and cost savings of a system optimized to work at peak efficiency.

The training workshop, which has been presented at more than 20 locations across the country since November 1999, helps users get the most benefit from the software, while emphasizing the systems

approach. According to Chris Cockrill of DOE, "The workshops have been a good way to introduce PSAT to end users, and we've seen a high demand for the software and the training."

He adds, "To meet this demand and increase the number of PSAT experts in industry to assist end users, DOE turned to the pumping industry and DOE's Allied Partnership with the Hydraulic Institute."

Last February, as a result of a PSAT demonstration at HI's annual meeting, several members decided to participate with DOE as BestPractices Allied Partners and to become qualified by DOE as Pumping System Specialists.

Don Casada of Diagnostic Solutions (formerly of Oak Ridge National Laboratory) designed the workshop, in collaboration with DOE and the pumping system industry. Casada, a recognized pumping system expert, also developed a pumping system prescreening tool. He was the instructor for the PSAT qualification workshop in Blacksburg, and for two additional qualifying workshops held this spring (April 26-27 for ITT Fluid Technology, in Morton Grove, Illinois, and May 14-15 for Flowserve Corporation, in Dallas, Texas). According to Casada, "What makes this workshop unique is its focus on practical analytical techniques for achieving greater system efficiency."



**Workshop participants gain hands-on experience with PSAT by conducting tests and collecting measurements at a VPI Water Authority pumping facility.**

The qualifying workshops prepare professionals with extensive experience in pumping systems to use PSAT in their system assessments. Participants learn:

- How to accurately acquire input data for PSAT
- How to prescreen pumping systems to select the "vital" systems for further review
- How to use the PSAT software
- The difference between measurements and requirements
- The importance of a system perspective.

To reinforce what was learned in the Blacksburg workshop, the class visited two pumping facilities of the Blacksburg-Christiansburg-Virginia Polytechnic Institute (VPI) Water Authority, where they conducted tests and collected measurements under different power scenarios. Participants entered the data into PSAT to determine each facility's pump efficiency and calculate the potential energy and cost savings for each power scenario. "The access granted by the Water Authority provided an exceptional learning laboratory for participants," Casada explained.

Participants who complete the workshop and pass a qualifying exam will be recognized by DOE as Qualified Pump System Specialists, and will be listed on DOE's BestPractices Web site at [www.oit.doe.gov/bestpractices](http://www.oit.doe.gov/bestpractices). Specialists assist

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**Back row (left to right): Arnold Sdano, Fairbanks Morse; Don Casada (Instructor), Diagnostic Solutions, LLC; Dewey Eanes, Jr., Blacksburg-Christiansburg-VPI Water Authority; Daryl Cox, Oak Ridge National Laboratory; Charles Karpa, Jr., Draper Aden Associates; and Mark Bihl, Sterling Fluid Systems (USA), Inc. Front row (left to right): Thomas Angle, EnviroTech Pump Systems; Fred Glaeser, Rutgers; Jeff van Huet, Science Center, University City; Tim Ritz, Fairbanks Morse; and Tom Brownfield, Hydro-Aire. (Not shown: G.W. (Jerry) Higgins, Blacksburg-Christiansburg-VPI Water Authority).**

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## California Workshops to Focus on Improving Efficiency and Reducing Demand

In partnership with the California Energy Commission, OIT's BestPractices will host "Energy Solutions for California Industry: Ways to Improve Operations and Profitability," a series of 1-day workshops to help California industries improve system efficiency and reduce electrical demand. The first event will take place on August 14, 2001, at the Radisson Hotel in Sacramento. The workshops are timely in view of California's energy supply dilemma, which will likely continue for some time. The events will be offered in cooperation with BestPractices Allied Partners, key industrial end user associations, and California utilities.

### Who Should Attend?

You should attend these workshops if you are interested in learning ways to manage and improve system efficiency in your plant. The August event will feature exhibits and speakers offering practical advice and solutions for managing electrical demand and improving system efficiency, while maintaining or improving productivity and profitability. Case studies will be presented to illustrate how electrical reduction can be achieved by using a systems approach.

The emphasis will be on financial, technical, and program assistance to help industries quickly and economically develop projects. Find out how to shop for financing and technical assistance. You

can also take away information and analytical tools that can help your facility increase energy efficiency and cost savings in the short term and long term.

Cosponsors of the August event are the Association of California Water Agencies, the California Farm Bureau Federation, the California League of Food Processors, and the California Manufacturers and Technology Association.

### Find Out More

For more information and updates about the workshops, check the BestPractices Web site at [www.oit.doe.gov/bestpractices](http://www.oit.doe.gov/bestpractices). ●

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### Quantification Workshops *continued from page 5*



**Instructor Don Casada guides PSAT workshop participants through pumping system calculations.**

industrial customers in using PSAT to evaluate their pumping systems.

To date, these seven companies have signed on as Allied Partners with plans to qualify representatives as Pump System Specialists:

- Burgmann Seals
- EnviroTech Pump Systems
- Fairbanks Morse
- Flowserve Corporation
- HydroAire
- ITT Fluid Technology
- Sterling Fluid Systems (USA), Inc.

In addition, DOE's Industrial Assessment Center at the University Science Center in Philadelphia, Pennsylvania, has a qualified specialist.

If you are a pump system professional interested in the PSAT qualification process, please contact Vestal Tutterow, Lawrence Berkeley National Laboratory, at 202-646-7957 or [vctutterow@lbl.gov](mailto:vctutterow@lbl.gov). The PSAT software is also available for download from the BestPractices

Web site. Check the BestPractices training calendar regularly at [www.oit.doe.gov/bestpractices/take\\_class/calendar.shtml](http://www.oit.doe.gov/bestpractices/take_class/calendar.shtml) for announcements of upcoming PSAT qualification workshops. ●

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### "NEMA Premium" Program *continued from page 4*

"NEMA and its members have the technical standards, knowledge, and ability to help industrial motor users evaluate motor systems and select the best motor for specific applications," said Chris Cockrill of DOE. "Our research shows that energy efficiency is one of several important factors for achieving the best overall motor system efficiency. The NEMA Premium efficiency standard builds on NEMA's other standards to ensure that end users consider all system variables," he explained.

The 21 member companies of NEMA's Motor and Generator Section support this effort. These companies account for more than 1.5 million motors manufactured, or more than 80% of all motors sold annually in the United States. NEMA has also worked with other organizations and associations that share an interest in motor efficiency, such as the American Council for an Energy-Efficient Economy, the Electrical Apparatus and Service Association (EASA), and the Consortium for Energy Efficiency.

NEMA launched the program and hosted a booth at the EASA Convention in Chicago, Illinois, on June 24-27. For more information about the NEMA Premium program visit [www.nema.org](http://www.nema.org). ●